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ABSTRACT

Based on a preliminary examination of over 1,200 article titles and abstracts and a subsequent review of selected articles, this booklet presents in highly abbreviated tabular format the most important research in the field of instructional microcomputing, including both computer assisted and computer managed instruction in elementary, secondary, and postsecondary education. It is noted that a more detailed synthesis of the research has also been published (IR 011 208). Research topics covered in the booklet include computer literacy and the use of microcomputers in general learning and for instruction in mathematics, music, reading, science, and typing. For each of the 22 studies listed, information is provided on authors, date of publication, topic, population studied, methodology, and outcomes. A survey by Henry Jay Becker, concerned with the distribution of microcomputers in schools in the United States, is described in more detail and information is quoted directly from the Becker study on the typical micro-owning elementary and secondary school. It is concluded that instructional microcomputing has been demonstrated to be a valuable educational tool and most effective as an adjunct to traditional instructional tactics. Also provided are bibliographic citations for each of the research studies tabulated and lists of the advisory board members and regional exchange staff of the Southwest Educational Development Laboratory. (ESR)

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THE EFFECTIVENESS OF MICROCOMPUTERS IN EDUCATION
A QUICK GUIDE TO THE RESEARCH

U.S. DEPARTMENT OF EDUCATION
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by
Floyd D. Ploeger

R & D Speaks: Effectiveness of Microcomputers in Educational Applications

September 27-28, 1983

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Southwest Educational Development Laboratory

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INTRODUCTION

The following tables convey, in a highly abbreviated form, some of the results of a survey of the research which was completed, by Floyd D. Ploeger, Ph.D., for the Southwest Educational Development Laboratory in Austin, Texas. The studies have been arranged according to the content area in which the research was conducted. This grouping is believed to provide for a more meaningful presentation of the research.

The procedure for the original study involved an exhaustive search of the literature. More than twelve hundred article titles and abstracts were identified for potential inclusion in the study. Each of the titles and abstracts were judged to determine whether a research study had been conducted in the area of instructional microcomputing. Following the judging, the author obtained copies of all articles which were determined to report on research endeavors concerning instructional microcomputing. The selected articles were carefully synthesized. Each article which has been included is believed to have been completed on microcomputers and pertains directly to the area of instructional microcomputing. The literature cited in this quick guide has been included to provide a bibliographical reference for the each of the specific research studies.

The original work includes a bibliographical citation for each of the articles which were reviewed but not necessarily synthesized. The complete bibliography is intended to provide a basis from which others might begin specific research endeavors without having to resort to such an exhaustive effort. Those interested in obtaining reproductions of the original study should contact the Southwest Educational Development Laboratory.

SURVEY OF MICROCOMPUTER USE

The Becker (1983) study is the most comprehensive and timely survey conducted concerning the distribution of microcomputers in education in the United States. The study reports the findings, identifies the assumptions and makes inferences which are supported by the data. Researchers and research articles of this caliber are rare. Anyone having an interest in the distribution of microcomputers in educational institutions in the United States would be well advised to obtain a copy of the Becker study. Only part of the study has been published as of the date of this report; however, it is available in continuing newsletter format.

The Becker study is based upon a sample of 2,209 schools in the United States from which a 96% return rate of the questionnaire was obtained. The researchers were able to obtain this unusually high rate of return through telephone follow-up contact. Both parochial, private and public institutions were contacted at the elementary through high school levels. The study reports on data for the period beginning in June, 1980 and ending in January, 1983. The study suggests that the use of microcomputers in the schools, though widespread, is not as pervasive as has been suggested.

Although somewhat irregular, this author has chosen to quote directly from the Becker study instead of attempting a synthesis. The findings of the study are extensive and of such a nature that graphs and involved explanations would be required. Further, the Becker study is well written and requires little editorializing. The following three paragraphs are taken directly from the Becker study and are believed to be an excellent summary of the typical use of microcomputers as determined by this national survey study.

"I: Micro-Owning Elementary Schools

The typical microcomputer-owning elementary school has two microcomputers, each used for about 11 hours per week, or a total of 22 hours of use per week by students under the direction of a teacher or other staff member. About 62 students (in the student body of 400) share these 22 hours of use, which is equivalent to about 20 minutes per user per week.

If computer time at this 'typical' school were divided among activities according to the average or mean use of student instructional time (as we estimate it from reported and imputed use in elementary schools), we would find the following distribution of uses: Approximately 40% of all instructional time on the microcomputer is spent by having students use computer programs for practicing math and language facts, spelling drills, and various other memorization tasks. Approximately one-third of the instructional time on the microcomputer is spent having students copy, write, and test computer programs. Students spend most of the rest of the time (about 20% in all) playing games under the direction or approval of the teacher. Many of these are 'learning' games, presumably designed to be 'drill-and-practice' assignments presented in a more entertaining, and presumably more motivating, guise.

II: Micro-Owning Secondary Schools

The typical microcomputer-owning secondary school has approximately five microcomputers, each in use for 13 hours per week, or a total of 65 hours of use. About 80 students (in a student body of 700) use the equipment in an average

week--a little more than 45 minutes per user. Programming and computer literacy activities occupy fully two-thirds of the instructional time on computers in secondary schools. 'Drill-and-practice' activities take up another 18% and the remainder is split among 'learning games,' various advanced applications such as word processing, science lab work, and business courses, and other activities."

The Becker (1983) study provides a basis upon which to build an understanding of the microcomputer research. It is obvious from the study that most students have very little opportunity to spend time using the microcomputer. Therefore, many research studies must be conducted in special environments with unusually high ratios of students to microcomputers. Those schools in which studies have been conducted, by definition, are special cases. Thus, the research should be closely scrutinized for instances of assumptions which would undermine the generalizability of the results. This does not suggest that the studies are not valuable. On the contrary, any well done study serves to provide information concerning the effective use of this new technology. In attempting to apply the results of research studies, care must be taken to maintain an environment which is similar to the environment in which the research was conducted. Applications which are successful may result in significantly different results when essential differences are overlooked. The point is that, because of the numbers of subjects required for statistical significance, research outcomes may apply only in specific situations. A particular school learning environment may not be afforded the luxury of student to microcomputer ratios comparable to those of the research studies. The Becker study serves to illuminate the incidence of microcomputers and thus serves as a stage for discussing current research concerning microcomputing.

RESEARCH IN GENERAL LEARNING

AUTHOR, DATE	TOPIC	POPULATION	METHODOLOGY	OUTCOMES
Cox, 1980	Problem solving to collect, organize, analyze, develop, and seek solutions.	66 seventh and eighth graders	Experimental group was given 10 min. training session. They were given 50 min. problem solving sessions using a microcomputer on 3 successive days or 3 consecutive weeks, in pairs and in groups.	Short training sessions on microcomputers can effect problem solving tactics of students over the long term. Shorter periods on the microcomputer may be useful in enhancing retention among the students.
duBoulay and Howe, 1981	Use of LOGO to enhance math scores	12 second and third year education majors in college	Aptitude tests revealed that experimental and control group had a dislike for math and a preference for teaching. The experimental group was taught LOGO on a microcomputer.	The use of LOGO has no effect on students' attitudes toward math nor on math achievement scores.

RESEARCH IN GENERAL LEARNING

AUTHOR, DATE	TOPIC	POPULATION	METHODOLOGY	OUTCOMES
Hamada-Adler & White, 1982	To compare learning approaches of children and adults using BASIC.	10 college students and 10 fourth and fifth graders.	Verbal interaction was used to determine the time-on-task. "Computer output" was used as a measure of performance.	Adults were observed to use similar strategies to children. Adults made more negative verbalizations than children. Adult "computer output" was significantly greater than that of the children.
Howe and Ross, 1981	The effect of LOGO on math ability of below average and above average students.	22 boys ranging in age from 11 to 13 years.	Measured the math ability and the attitude toward math of the subjects. Students were taught LOGO.	Experimental group had lower scores on the pretest than did the control. Both experimental and control group increased significantly in math achievement. Indicates that LOGO can increase math achievement, at least, as well as regular instruction. No difference on posttest scores.

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RESEARCH IN GENERAL LEARNING

AUTHOR, DATE	TOPIC	POPULATION	METHODOLOGY	OUTCOMES
Lewis, 1981	Use of LOGO by young children.	3 and 4 year old children	Compared microcomputer use time of 3 year olds vs 4 year olds. Children interacted with four LOGO procedures: People, Park, Dallas and Build. Microcomputer time use was recorded over an 18 day period.	No difference in use by 4 year olds as compared to 3 year olds. Students chose to use the Dallas procedure for greater lengths of time than any other procedure. Indicates that an open ended procedure is more appealing to these children.
Seidman, 1981	Effect of LOGO on formal logical reasoning ability.	42 fifth graders	Experimental group was taught LOGO on a minicomputer. Experimental and control group were tested on the vocabulary, comprehension, computation and concrete measures of the California Achievement Test.	No evidence that LOGO or any other programming language influences the logical reasoning ability of the subjects.

RESEARCH IN COMPUTER LITERACY

AUTHOR, DATE	TOPIC	POPULATION	METHODOLOGY	OUTCOMES
Johnson, Anderson, Hanson, and Klassen, 1981.	Collection of data about students' literacy and the relative impact of computer use on computer literacy.	3,500 teachers were surveyed and 929 students were tested.	Result of 1977-79 survey was set of 54 objectives in the cognitive domain concerning hardware, programming and algorithms, software and data processing, applications, impact, and motivation. Experimental group was given various microcomputer related activities and were given the Minnesota Educational Computer Consortium computer literacy test.	Computer literacy is increased by providing microcomputer-related activities without teaching computer literacy to the students.

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RESEARCH IN MATHEMATICS

AUTHOR, DATE	TOPIC	POPULATION	METHODOLOGY	OUTCOMES
Hart, 1981.	Use of BASIC to expose students to concept of variable assignment in math.	24 elementary school children.	Experimental group used BASIC during 15 min. sessions once every 3 to 4 weeks to assign variables and numeric values. No control group was used.	Achievement gains among first year students were comparable to the achievement gains of regular third year students.
Klienman, Humphrey, and Lindsay, 1981.	Compare attention span on arithmetic problems using the microcomputer vs paper and pencil.	18 hyperactive 6 to 14 year old children.	Subjects used paper and pencil on alternating days with the microcomputer. Difficulty-adjusted arithmetic problems were presented. The subjects were allowed to work as many problems as they chose.	Attention span significantly increased without loss of accuracy or speed when using microcomputer as compared to paper and pencil.

RESEARCH IN MATHEMATICS

AUTHOR, DATE	TOPIC	POPULATION	METHODOLOGY	OUTCOMES
Moser, and Carpenter, 1982	Microcomputer used to aid in solving verbal problems by using symbolic representation.	4 first graders	The students used the microcomputer as an aid in solving addition and subtraction problems using a visual display. Up to 30 boxes could be put on the screen at one time to represent the problem.	Students could not solve any of the word problems prior to experience, but could solve the problems after the experience. Microcomputer can aid in solving verbal problems by permitting concrete display of an abstract problem.
Steele, Battista, and Krockover, 1982	Use microcomputer to enhance computer literacy and math achievement.	30 first graders	Experimental and control group used similar math drill exercises. Experimental group used drill and practice program on microcomputer. Minnesota Computer Literacy and Awareness Assessment was used as computer literacy measure.	Gains in measured mathematics ability were detected. Significant gains in computer literacy and attitude improvement was reported even though neither was taught as a content. Computer literacy can be increased through microcomputer use without specifically being taught.

AUTHOR, DATE	TOPIC	POPULATION	METHODOLOGY	OUTCOMES
Gross and Griffin, 1982	Use of the micro-computer to enhance music aural skills	16 college freshman.	Subjects were given two 20 minute learner controlled microcomputer sessions per week during a five week pilot program.	The subjects' ability to identify intervals and chords was determined increased. No achievement gains were identified for melodies, scales, and progressions.

AUTHOR, DATE	TOPIC	POPULATION	METHODOLOGY	OUTCOMES
Havlicek, and Coulter, 1982.	A computer managed instruction (CMI) program was used with a reading program.	220 junior college students	The effectiveness of the CMI program was tested by using an experimental and control group in reading. The CMI program scheduled assignments, kept test results, gave progress reports and analyzed data.	The students achieved significant gains in scores on vocabulary, comprehension, and composite measures of achievement on the Nelson-Denny Reading Test.
Henny, 1983.	Tested differences in reading mixed-case vs all capital letters in text.	47 sixth graders and 72 college students.	Used the "Basic Reading Test" as revised by R.P. Carver to to assess reading speed and accuracy. The video display screen was used to present the text to the subjects in both upper-lower case and all in capital letters.	Reading speed was greater for the college students using the mixed upper-lower case letters. Elementary students showed no difference. The accuracy level was greater for all capital letters. Supports teaching younger students reading using upper-lower case letters.

AUTHOR, DATE	TOPIC	POPULATION	METHODOLOGY	OUTCOMES
Anderson, Klassen, Hansen, and Johnson, 1980.	Measured difference in knowledge of content for micro-computer using group vs non-micro-computer group.	340 ninth and eleventh graders	Experimental group interacted with microcomputer in which a simulated malfunction ends the program. Affective measures of awareness, self-efficacy, enjoyment, self-esteem, and anxiety were made.	Significant increase in efficacy and motivation concerning computer literacy but, reduced anxiety. The simulated malfunction reduced the computer efficacy which suggests equipment failures reduce student performance.
Ploeger, 1981.	Use of computer to simulate science classroom laboratory safety.	52 pre-service teachers at the elementary level	Randomized Solomon Four-Group design was used. Experimental subjects interacted with micro computer program simulation of science laboratory containing safety hazards. Used black & white line drawing to depict science laboratory.	Significant increase in ability of pre-service teachers to identify safety hazards created by students in science classroom laboratory.

AUTHOR, DATE	TOPIC	POPULATION	METHODOLOGY	OUTCOMES
Ploeger, 1983	Comparison of color to black and white visuals.	48 pre-service teachers at the elementary level	Microcomputer program was used to simulate science lab. Experimental group was given color line drawing but control group used black & white line drawing. Subjects identified hazardous situations in science classroom laboratory.	No significant difference was detected between the group using the color visual and the black & white visual. Suggests that color visual with microcomputer simulations does not enhance learning. Motivation was not measured in this study.
Soldan, 1982	Evaluation of use of microcomputer in college laboratory as instructional aid.	College biology students.	Students used interactive microcomputer programs in Population Growth, Predator Prey and Mitosis/Meiosis as an aid to laboratory instruction. Courseware was developed for SUMIT Project.	Subjects were asked if they had used microcomputer program to determine experimental grouping. Based on this procedure, no difference was found between group reporting use of the microcomputer and non-using group.

AUTHOR, DATE	TOPIC	POPULATION	METHODOLOGY	OUTCOMES
Spain, 1982.	Comparison of written, lecture, and microcomputer instruction in science.	College biology students.	Nine microcomputer modules were used to compare written & lecture instruction. Students attended classes which used alternate modes of instruction	The researchers report that the microcomputer instruction was at least as effective as the standard lecture. The written instruction mode was the least effective mode.
Wise, and Okey, 1983.	Meta-analysis of microcomputing research in science	1000 studies surveyed and 12 included.	Literature search was made in the Resources in Education (RIE) and Current Index of of Journals in Education(CJIE) to identify studies which were microcomputer studies in the area of computer assisted instruction. Articles were restricted to the dates of January 1979 to June 1982.	Results suggest that instructional microcomputing can be expected to account for some gains in learner achievement. This and other studies agree regarding the magnitude or the gains. Study supports the notion that the body of research is growing in the area of instructional micro-computing.

AUTHOR, DATE	TOPIC	POPULATION	METHODOLOGY	OUTCOMES
Zielinski, 1981	Use of micro-computer chip based energy simulator.	104 middle school children	Control group participated in a 10 day unit on energy. Experimental group interacted once with the environmental energy simulator for 55 min. Measures of achievement and attitude were taken.	No significant difference was detected between the experimental group and the control group on the achievement or attitude measure.

RESEARCH IN TYPING

AUTHOR, DATE	TOPIC	POPULATION	METHODOLOGY	OUTCOMES
Lindsay, 1982.	Comparison of microcomputer and electric typewriter in keyboarding.	105 high school students.	Experimental group used a microcomputer simulation to practice typing skills. The control group used IBM electric typewriters. Straight copy speed was used as a measure of achievement.	The study results suggest that for straight copy, the microcomputer is as effective at teaching speed and straight copy as are electric typewriters. The affective features of flexibility, freedom to reinforce learners, and motivation support a preference for microcomputers.

CONCLUSIONS

This brief work, The Effectiveness of Microcomputers in Education: A Quick Guide to the Research, is designed to provide access to research in the field of instructional microcomputing in a manner which is understandable. The chart form has been chosen in the belief that areas of particular interest may be located with a minimum of effort. It is recommended that the detailed synthesis of the research, The Effectiveness of Microcomputers in Education, be obtained from the author through the Southwest Educational Development Laboratory.

The research which has been included is believed to be well done, timely and of significance value to those interested in instructional microcomputing. The survey studies have been reported in order to provide a framework from which to view the research. It is believed that appropriate application of research serves to enhance effective educational strategies.

The research has clearly demonstrated that instructional microcomputing can be a valuable educational tool. The studies support the belief that affective measures such as motivation and self-esteem are enhanced as a result of the inclusion of microcomputers in an instructional setting. Time-on-task may be expected to increase and problem solving strategies may be altered among students. The BASIC programming language was demonstrated to improve math skills while the use of LOGO neither supported increasing math skills nor formal reasoning skills. Interestingly, computer literacy may be improved simply by encouraging student use of microcomputer. Computer literacy need not be taught as a separate content.

The use of instructional microcomputing has been demonstrated to be most effective as an adjunct to normal or traditional instructional tactics. Instruction has been demonstrated to be most effective when instructional objectives are clearly identified and appropriate for the learner. As with any instructional methodology, inappropriate application of any tactic seldom provides satisfactory results.

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